Presence in a Collaborative Science Learning Activity in Second Life

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Introduction

Following Dede's description of "'Alice-in-Wonderland' multi-user virtual environments interfaces" that would "shape how people learn" (2002), nowadays, *Multi-user virtual environments* (MUVEs) are being surrounded by hype regarding their impact on and potential in education. Their support to constructivist approaches to teaching and learning seems to be of major importance for educators and researchers. MUVEs can provide rich learning experiences, enhance the sense of (social) presence of learners, and allow multifaceted interaction.

Some MUVEs have been designed specifically for educational use, like *River City*, a MUVE fostering inquiry-based learning (Ketelhut 2007), *AquaMoose3D*, a graphical MUVE for mathematics learning (Edwards et al. 2001), and *Quest Atlantis*, a 3D multi-user environment which engages children in educational tasks (Barab et al. 2005). On the other hand, general-purpose MUVEs are more widely used in many educational settings and domains of subject matter. *Second Life® (SL)* seems to be the most popular MUVE among educators. In higher education, SL has attracted a great deal of attention, with over 400 academic institutions holding a virtual presence in it (Campusin3D.com, n.d.), more and more official courses are being offered "in-world" and classes are taught in architecture, English as a second language, science, engineering, law, computer science, history, arts, etc. (Calgone and Hiles 2008). SL is a persistent (24/7) computer-generated virtual world with no pre-made content. Rather, its residents are creating the content. It is a platform with open-ended possibilities which can be utilized to develop educational virtual environments and to design learning activities.

As often happens when hype prevails, there are many issues regarding the educational affordances of MUVEs that are still under-reported such as how educators

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design learning activities, with specific learning goals to be conducted in MUVEs and even less data comes from empirical studies related to instructional design and pedagogy in MUVEs. A very important and unique characteristic of educational virtual environments that seems to play an important role in learning and is also not well reported is the sense of spatial and social presence (Mikropoulos 2006; Winn and Windschitl 2000; Selverian and Lombard 2010) that emerges when humans interact with and via a virtual environment.

Presence is a central conceptual phenomenon related to virtual environments, which Lombard and Ditton (1997) excellently described as "the perceptual illusion of non-mediation," the phenomenon where a person fails to perceive or acknowledge that a mediated experience is mediated. A major branch of presence conceptualization defines presence as consisting of two interrelated phenomena: spatial presence (also known as physical presence or telepresence) and social presence (Heeter 1992; Biocca 1997; Ijsselsteijn et al. 2000; Biocca and Harms 2002; Biocca et al. 2003). Spatial presence refers to the "sense of being physically located somewhere" (Ijsselsteijn et al. 2000) while social presence refers to "being with others" in a mediated environment (Heeter 1992). Many factors have been suggested as possibly affecting the sense of presence, including media form factors, content factors, and user characteristics (Ijsselsteijn et al. 2000). Presence measuring is following two major methodological strands, subjective measuring and objective-physiological measuring, but it seems that subjective post-test ratings are the most widely used methods to approach presence measuring. Among others, the following questionnaires have been developed to access presence: the Slater–Usoh–Steed (SUS) Questionnaire (Slater et al. 1994), the Presence Questionnaire (PQ) (Witmer and Singer 1998), the Igroup Presence Questionnaire (Schubert et al. 2001), and the Temple Presence Inventory (TPI) (Lombard et al. 2009).

This work is part of a research project that aims at designing learning activities in order to study learning in MUVEs in terms of learning outcomes, collaboration, and presence. In the first study of this project (Vrellis et al. 2010) an authentic, collaborative learning activity concerning light reflection was designed and developed in Second Life. First results concern educational environment design issues, collaboration, and instructional issues.

Regarding design issues, students prefer to perform the whole learning activity in the educational virtual environment. That is, they want "in-world" intuitive object manipulation, educational material, and tools that work in the environment, instead of "out of world" dialogue menus, browsers, and tools that could distract their attention from the environment and learning activity. Even though virtual environments allow object manipulation at user's will (all degrees of freedom), restricting degrees of freedom to the necessary ones, depending on the specific instructional design and educational scenario, has no negative effect on creating an engaging authentic learning task. Moreover, students prefer to perform activities in settings relevant to the specific educational scenario, even out of the conventional "classroom representation" setting.

As far as collaboration is concerned, results show that participating in collaborative learning activities conducted in MUVEs is very important for their education and they evaluated positively the presence of a tutor in the activity. They felt that they could interact with the other participants and evaluated their experience as interactive and sociable. Students prefer to collaborate through rich communication channels that do not filter out important nonverbal communication signals.

Finally, concerning instructional issues, the study reveals that pedagogical methods of constructivist approach, like scaffolding, can be implemented in SL through properly designed problem-based learning activities. This chapter presents empirical data gathered from a study regarding a problem-based physics learning activity in SL. Our aim is to gain knowledge and experience about the sense of presence (spatial and social) that emerges while students collaborate in MUVEs. This study is a step toward the investigation of the relationship between learning outcomes and presence.

Method

Virtual Environment and Learning Activity

The virtual environment was designed and developed in SL. It refers to physics learning and specifically to the reflection of light. The design of the learning activity was based on the seven principles of constructivism (Jonassen 1994):

- Provide multiple representations of reality – avoid oversimplification of instruction by representing the natural complexity of the world.
- Focus on knowledge construction not reproduction.
- Present authentic tasks.
- Provide real world, case-based learning environments.
- Foster reflective practice.
- Enable context, and content, dependent knowledge construction.
- Support collaborative construction of knowledge through social negotiation, not competition among learners for recognition.

The problem presents an authentic task in a “real” world environment. Students had to collaborate in order to shoot an apple down from a tree using a laser beam and a plane mirror (Fig. 1). They had to calculate the correct angle of the mirror in order to reflect the laser beam to the apple. Students were not allowed to use a trial and error approach. Instead, they had to use trigonometry for the calculation of the correct angle before shooting.

The following “in-world” tools were available to the students:

- Two virtual rulers for the measurement of horizontal and vertical distances.
- A poster presenting the law of reflection.
- Three posters presenting the trigonometric functions and values for sine, cosine, and tangent.
- An interactive whiteboard where students could draw sketches. The whiteboard had also a help button that presented a graphical model of the problem (Fig. 2).
- A virtual calculator.

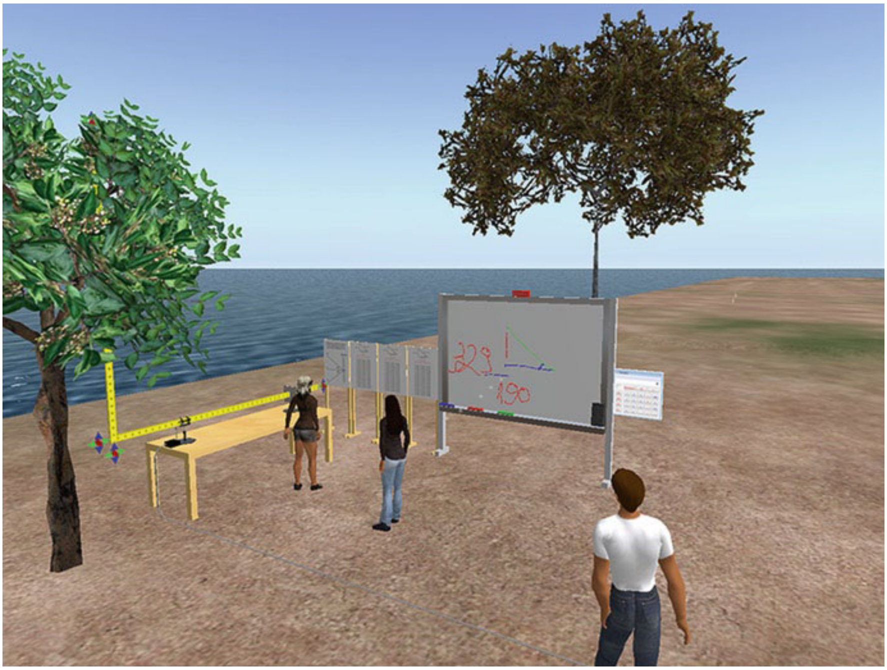

Fig. 1 The activity setting

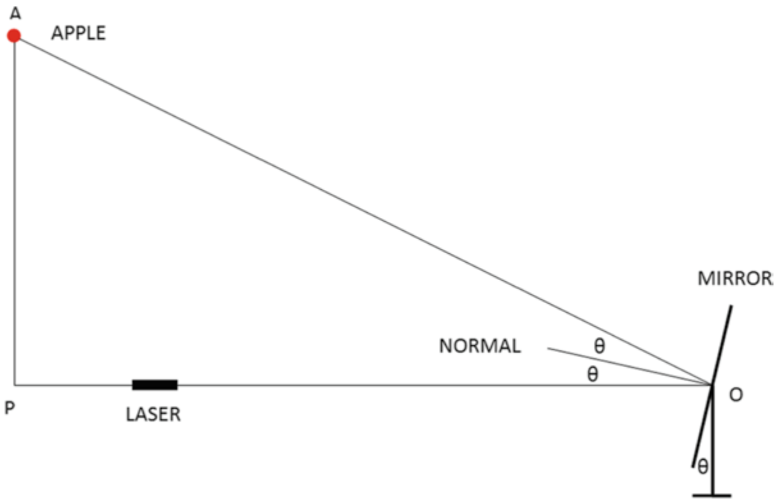

Fig. 2 A model of the problem

To solve the problem, students had to calculate the rotation angle of the mirror (θ) (Fig. 2). To do so, they had to recognize that θ = POA/2. The angle POA could be calculated through its tangent. So, first they had to measure the distances PO and PA by correctly positioning the rulers. Then, they had to divide the distances in order to find the tangent. Finally, by using the trigonometric tables, students could find the angle POA and thus θ.

Subjects

Thirty second-year, future teacher students (22 women, 8 men) of the University of Ioannina, participated in the study. Their ages were between 18 and 25 (Mean = 19.7, SD = 1.44). They all were experienced users of SL, since they had attended a class on potential educational uses of SL. Their participation was voluntary, motivated by a small bonus in their marks. The students registered in pairs for the collaborative activity.

Procedure

The empirical data was gathered from 15 sessions where a pair of students and the tutor participated. They were physically located in three different rooms and collaborated exclusively through SL. Each session lasted about 40 min. Before the experiment, the students answered a personal questionnaire on demographics, computer, and 3D-VR games experience, tendency to become involved in activities and previous knowledge related to light reflection and trigonometry.

Participants used their personal SL accounts and avatars to log in and were teleported to the Educational Approaches to Virtual Reality Technologies Lab's island in SL (Earthlab Education Island). There, they met the tutor who guided them to the activity's setting. The students and tutor communicated via the SL voice and text chat and their screens, microphones, and webcams were recorded.

The tutor made a brief introduction to the topic under study in a virtual classroom (Fig. 3). There, the students familiarized with the use of the available educational material and virtual objects and tools. After that, the participants walked outside the classroom, where the activity setting was located. The tutor posed the problem the students had to solve collaboratively and let them work, remaining nearby available to provide assistance.

After finishing the activity, the students answered a questionnaire measuring presence and took part in a debriefing interview with the tutor. The presence questionnaire used was the TPI that measures multiple dimensions of presence (Lombard et al. 2009).

Fig. 3 In the virtual classroom

Results

All pairs of students found the right solution to the problem with more or less scaffolding from the tutor. The following tables show the various dimensions of presence measured. Also some statistically significant correlations between these dimensions and the user characteristics are presented. Table 1 shows the results from the spatial presence part of the TPI questionnaire.

The overall score for spatial presence is 4.25 (SD 1.258). This value is little above the average indicating a moderate sense of spatial presence in the MUVE. This result is rather expected. SL is a desktop virtual environment that does not exploit all the available VR technologies. High scores of spatial presence are usually associated with highly immersive virtual environments.

Table 2 presents the results from the social presence – actor within medium (parasocial interaction) part of the TPI questionnaire. “In a parasocial interaction media users respond to social cues presented by persons they encounter within a medium even though it is illogical to do so” (Lombard et al. 2000).

The overall score for social presence is 5.29 (SD 0.837). The score is higher than that for spatial presence. This can be attributed to the nature of SL as a MUVE that enables social interaction and collaboration, as well as to the nature of our learning activity.

Table 1 Spatial presence

Questions	Minimum	Maximum	Mean	Standard deviation
How much did it seem as if the objects and people you saw/heard had come to the place you were?	1	7	4.37	1.771
How much did it seem as if you could reach out and touch the objects or people you saw/heard?	1	7	4.40	1.734
How often when an object seemed to be headed toward you did you want to move to get out of its way?	1	7	3.50	1.815
To what extent did you experience a sense of being there inside the environment you saw/heard?	2	7	4.77	1.591
To what extent did it seem that sounds came from specific different locations?	1	7	3.93	1.791
How often did you want to or try to touch something you saw/heard?	1	7	4.13	1.795
Did the experience seem more like looking at the events/people on a movie screen or more like looking at the events/people through a window?	1	7	4.60	1.958

Table 2 Social presence

Questions	Minimum	Maximum	Mean	Standard deviation
How often did you have the sensation that people you saw/heard could also see/hear you?	1	7	5.50	1.480
To what extent did you feel you could interact with the person or people you saw/heard?	4	7	5.63	0.928
How much did it seem as if you and the people you saw/heard both left the places where you were and went to a new place?	1	7	4.67	1.561
How much did it seem as if you and the people you saw/heard were together in the same place?	2	7	5.50	1.383
How often did it feel as if someone you saw/heard in the environment was talking directly to you?	3	7	5.70	1.291
How often did you want to or did you make eye-contact with someone you saw/heard?	1	7	4.57	1.455
Seeing and hearing a person through a medium constitutes an interaction with him or her. How much control over the interaction with the person or people you saw/heard did you feel you had?	3	7	5.47	1.279

Table 3 Social richness

Questions	Minimum	Maximum	Mean	Standard deviation
Please circle the number that best describes your evaluation of the media experience: Remote – Immediate	3	7	5.83	1.147
Please circle the number that best describes your evaluation of the media experience: Unemotional – Emotional	1	7	4.87	1.548
Please circle the number that best describes your evaluation of the media experience: Unresponsive – Responsive	4	7	6.20	0.925
Please circle the number that best describes your evaluation of the media experience: Dead – Lively	3	7	6.00	1.259
Please circle the number that best describes your evaluation of the media experience: Impersonal – Personal	1	7	5.60	1.404
Please circle the number that best describes your evaluation of the media experience: Insensitive – Sensitive	1	7	5.07	1.438
Please circle the number that best describes your evaluation of the media experience: Unsociable – Sociable	3	7	5.83	0.986

Table 4 Social realism

Questions	Minimum	Maximum	Mean	Standard deviation
The events I saw/heard would occur in the real world	3	7	5.53	1.383
The events I saw/heard could occur in the real world	1	7	5.72	1.412
The way in which the events I saw/heard occurred is a lot like the way they occur in the real world	2	7	5.20	1.400

Table 3 shows the results from the questions concerning social richness. Social richness as a dimension of presence is the extent to which users perceive the virtual environment, when it is used to interact with others, as sociable, warm, sensitive, personal, or intimate (Lombard et al. 2000).

The overall score for social richness is 5.63 (SD 0.990). The score is well above the average. Specifically, the students found their experience as highly responsive (6.20, SD 0.925) and lively (6.00, SD 1.259).

Table 4 presents the mean values for social realism. The social realism questions evaluate whether the portrayed events would or could occur in the real world.

The overall score for social richness is 5.48 (SD 1.225). This score is also high and in accordance with the previous two social dimensions of presence (social presence and social richness).

Table 5 Engagement (mental immersion)

Questions	Minimum	Maximum	Mean	Standard deviation
To what extent did you feel mentally immersed in the experience?	2	7	5.13	1.456
How involving was the experience?	3	7	5.80	1.157
How completely were your senses engaged?	2	7	5.00	1.390
To what extent did you experience a sensation of reality?	1	7	4.93	1.507
How relaxing or exciting was the experience?	1	7	5.27	1.639
How engaging was the story?	3	7	6.37	0.928

Table 6 Engagement and presence correlations

Engagement (mental immersion)		
Spatial presence	Pearson Correlation	0.587
	Sig. (2-tailed)	<0.01
Social presence	Pearson Correlation	0.643
	Sig. (2-tailed)	<0.01
Social richness	Pearson Correlation	0.739
	Sig. (2-tailed)	<0.01
Social realism	Pearson Correlation	0.487
	Sig. (2-tailed)	<0.01

Engagement with the learning activity is an important parameter that contributes to learning outcomes regardless of whether the learning environment is mediated or not.

Table 5 shows the results concerning the engagement of students in the experience. The overall score for engagement is 5.42 (SD 1.049). It is remarkable that students found the story (activity) very engaging (6.37, SD 0.928). This result indicates that the instruction design based on constructivist approaches incorporating authentic tasks engage students in the learning activity.

Below some of the statistically significant correlations found between the variables are presented.

Table 6 shows the correlations between engagement and various components of presence. It is clear that engagement and other dimensions of presence are strongly correlated. This implies that an engaging constructivist learning activity can increase the sense of presence of the learner.

Other interesting findings were the negative correlations between (subjective) computer expertise and the sense of spatial presence ($r=-0.384$, $p<0.05$) and engagement ($r=-0.437$, $p<0.05$). This would imply that the more experienced a user considers herself in computer usage, the more difficult it is for her to feel present in the MUVE. Nevertheless this finding should be regarded cautiously since no significant correlations between other subtypes of computer expertise (internet, video-games, virtual environments, SL) and presence or engagement were found.

Table 7 shows that some variables indicating the user's tendency to become involved in activities are correlated with her sense of spatial presence.

Table 7 Tendency to become involved in activities and spatial presence

Spatial presence		
I concentrate well also on disagreeable tasks	Pearson Correlation	0.407
	Sig. (2-tailed)	<0.05
Sometimes I am so involved in a game that having the impression of being part of the game rather than moving a joystick or watching the screen	Pearson Correlation	0.440
	Sig. (2-tailed)	<0.05
I have been scared by something happening on a TV show or in a Movie	Pearson Correlation	0.522
	Sig. (2-tailed)	<0.01

Conclusions

This chapter presents empirical data about the sense of presence (spatial and social) gathered from a study regarding a collaborative problem-based physics learning activity in SL. Even though exploratory studies like this tend to generate more questions than answers, first results suggest that constructivist collaborative learning activities in a MUVE like SL have the potential to engage students. Furthermore, the social dimensions of presence scored well above average while spatial presence remained average, which is rather expected because SL is a socially oriented MUVE based on nonimmersive desktop technology. Moreover, strong positive correlations between engagement and other dimensions of presence were observed, while subjective computer expertise seemed to be negatively correlated to spatial presence and engagement, although these findings should be regarded with caution. Finally, the users' tendency to become involved in activities seems to be related to the sense of spatial presence they experience in MUVE-like environments.

The above results constitute a basis and also a motivation toward the investigation of the relationship between presence and learning outcomes from learning activities in SL.

Our next step toward this investigation includes the analysis of screen, webcam, and voice recordings in order to assess qualitative aspects of presence and collaboration.

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